MODEL 410
SIGNAL GENERATOR

SERIAL NOS. PREFIXED A

CAL/CERT

E-H RESEARCH LABORATORIES, INC.
163 ADELINE STREET · OAKLAND 20, CALIFORNIA

MP MASTER
MA35721

MODEL 410
SIGNAL GENERATOR

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TABLE OF CONTENTS

SECTION I GENERAL INFORMATION

1.1	General	I - 1
1.2	Applications	I - 1
1.3	Specifications	I - 1

SECTION II OPERATING INFORMATION

2.1	Frequency Selection	II - 1
2.2	Amplitude and Attenuator Controls	II - 1

SECTION III THEORY OF OPERATION

3.1	Circuit Description	III - 1
3.2	Oscillator	III - 1
3.3	Preamplifier	III - 1
3.4	Output Amplifier	III - 2
3.5	Meter Circuit	III - 2
3.6	Attenuator	III - 2
3.7	Power Supply	III - 2

SECTION IV MAINTENANCE & CALIBRATION

4.1	Components	IV - 1
4.2	Fan Assembly	IV - 1
4.3	Test Equipment	IV - 1
4.4	Performance Check	IV - 1
4.5	Calibration Procedure	IV - 2
4.6	Meter Calibration	IV - 3
	Figure 4-1 - D-10830 Amplifier	IV - 3
	Figure 4-2 - D-10830 Oscillator/Preamplifier	IV - 4
	Figure 4-3 - D-10831 Power Supplies	IV - 4
	Schematic - D-10830	IV - 5
	Schematic - D-10831	IV - 7

SECTION V PARTS LIST

5.1	Ordering Information	V - 1
5.2	Warranty	V - 1

SECTION I
GENERAL SPECIFICATIONS

1.1 GENERAL

The E-H Model 410 Signal Generator is a precision test oscillator covering the wide frequency range from 10 cycles to 10 megacycles. Up to 180 milliwatts of power (3 volts into 50 ohms) is available at the output connector. Frequency response is flat to less than 0.5 db over most of the range, and the output signal is exceptionally clean. The dial calibration accuracy of ±2%, including all sources of error, eliminates the need for external frequency monitoring equipment in many applications.

1.2 APPLICATIONS

The Model 410 was especially designed for the convenient and accurate testing of circuits in the audio and video frequency range. This includes the testing of filters, video and audio amplifiers, and attenuators. In addition, the instrument is excellent for the alignment of receivers and telephone and telegraph equipment.

1.3 SPECIFICATIONS

FREQUENCY RANGE: 10 cps to 10 mc, continuously variable by a six-decade step and a dial calibrated from 1 to 10.

FREQUENCY RESPONSE: Properly terminated, the frequency response is better than ±0.5 db from 10 cps to 1 mc and better than ±1 db from 1 mc to 10 mc.

FREQUENCY STABILITY: Long-term stability is better than ±1% after warm up of 15 minutes and after remaining 5 minutes at any dial position.

DIAL ACCURACY: ±2% including frequency stability, calibration error and line voltage variations.

OUTPUT: Up to 3 volts rms into 50 ohms resistive (180 milliwatts) or up to 1.5 volts rms into 600 ohms from a 600 ohm source impedance. Two output connectors in parallel are provided on the front panel -- one is a Type BNC, and the other is a pair of binding posts.

OUTPUT METER: A voltmeter monitors the unattenuated output level in volts and dbm when the instrument is properly terminated. The accuracy is ±5% of the full scale reading.

HUM AND NOISE LEVEL: Less than .2% of the maximum rated signal level.

ATTENUATOR: Both a 50 ohm and a 600 ohm attenuator are provided. The 50 ohm attenuator provides 50 db attenuation in 10 db steps. Together the 50 ohm attenuator and amplitude controls provide a continuously variable output voltage from 3 volts to 3 millivolts into 50 ohms.

The 600 ohm attenuator provides up to 50 db attenuation in 10 db steps and is calibrated in volts and dbm. Together the amplitude control and the 600 ohm attenuator provide continuously variable output voltage from 1.5 volts to 1 millivolt (+6 dbm to -60 dbm).

Both the 50 ohm and the 600 ohm attenuators are accurate to ±1 db.

DISTORTION: Less than 1% from 20 cps to 100 kc; less than 2% from 100 kc to 1 mc; and less than 3% from 1 mc to 10 mc.

POWER REQUIREMENTS: 115/230 volts, ±10%, 50/60 cps.

WEIGHT: 15 lbs. net; 23 lbs. packed; 35 lbs. packed for export.

DIMENSIONS: Cabinet model is 12" wide, 6" high, and 9" deep. A 7" high rack adaptor is available.

SECTION II
OPERATING INFORMATION

2.1 FREQUENCY SELECTION

Two front panel controls determine the output frequency of this instrument.

The setting of the RANGE knob selects one of the six decades from 10 cps to 10 mc. The FREQUENCY control allows continuous adjustment within this decade.

A warm-up period of at least 15 minutes should be allowed for the best accuracy and stability of the oscillator.

2.2 AMPLITUDE AND ATTENUATOR CONTROLS

The amplitude of the signal appearing at the output terminals is adjusted using the continuously variable AMPLITUDE control and the twelve-position step attenuator.

The AMPLITUDE knob controls the signal level delivered by the amplifier to the attenuator input. This level is continuously indicated by the OUTPUT meter, regardless of the attenuator setting.

Six output levels for the 50-ohm loads and six for the 600-ohm loads are provided in three/one steps by the attenuator switch.

Things to remember in using this instrument:

The two sets of output terminals, BNC and screw posts, are in parallel and deliver identical signals.

The output line must be terminated in either of the two standard impedances as selected by the attenuator switch setting, or the amplitude as read from meter and attenuator will be meaningless. Note that the amplifier is always terminated internally in its proper load of 50 ohms in all attenuator settings except 3 volts/50 ohms. In this setting it is recommended that the output line always be properly loaded and never be opened or shorted.

In switching from a "three" step on the attenuator to a "one" step or vice versa, the meter must be read on its corresponding scale (i.e., to get 1 volt output when set up for 3 volts, it is not enough merely to switch the attenuator down a step. The AMPLITUDE knob must also be retouched so that the meter indicates 1 volt on the red scale.)

In the frequency decade from 1 to 10 mc, the effect of shunt capacity becomes increasingly important. Whenever possible, the 50-ohm system should be used in this decade. At 10 mc a 200 pf shunt capacity will attenuate the signal delivered to a 600-ohm load by more than 10 db over that delivered to 50 ohms. At 600 ohms this small capacity also causes a 3:1 change in amplitude as frequency is varied over the decade; at 50 ohms, amplitude is flat within the specified ±1 db.

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SECTION III
THEORY OF OPERATION

3.1 CIRCUIT DESCRIPTION

The E-H Model 410 Signal Generator consists of a standard Wien bridge oscillator to cover the full frequency range of 10 cycles per second to 10 megacycles per second. The oscillator is followed by a two-stage amplifier which drives the output power amplifier. The output from the power amplifier is fed to the 12-section attenuator which provides six positions of 600 ohms and six positions of 50 ohms output impedance. The metering circuit monitors the output from the power amplifier (attenuator input) at all times.

3.2 OSCILLATOR

The amplifier for the Wien bridge oscillator consists of V1, Q1 and Q2; and the tuning is accomplished by the two-section variable capacitor C36. The decade range is selected by R43 to R54 on the RANGE switch. The input to the oscillator amplifier is the grid, pin 9 of V1. The output from V1 is taken from the plate and is coupled to the base of Q1 through the zener diode CR1, which is a 75-volt, 5% zener. C4 and C5 are used to filter the noise generated by the zener diode CR1. Zener operating current for CR1 is provided by R8. Q1 is operated as an emitter follower which drives the inverter Q2. The output from the oscillator amplifier is taken from the collector of Q2 and is fed to the Wien bridge resistors R43 to R48 and the variable capacitor C36. The collector of the transistor Q2 (the output of the oscillator amplifier) is at about +2 volts d-c with approximately a 4 volt peak-to-peak sine wave. The amplitude of the oscillation is stabilized by providing negative feedback to the cathode of V1 through thermistor R6.

As the amplitude of the oscillation builds up, the feedback power to R6 heats the thermistor up to the point where the loop gain around the amplifier is just three. R7 sets the operating point of V1. Diode CR2 prevents the base of Q2 from going too far positive in the event that Q1 opens or is removed from the socket with the +150 volt supply operating.

Heat power is provided by a 6.3 volt d-c regulated supply and the filaments are choked off with L2 and L3 to reduce the capacitive loading at the cathode of V1. The trimmer capacitor C37 across one section of the tuning capacitor C36 is used to make the two sections of C36 equal in capacity at the high end of the band. The trimmer capacitors C38, C39 and C40 compensate for the phase-shift which does occur in the oscillator amplifier and also compensates for the difference in stray capacity which shunts the bridge resistors R43 through R48.

3.3 PREAMPLIFIER

The preamplifiers consist of two stages of negative feedback amplifiers. The first amplifier consists of transistors Q3 and Q4; the second amplifier consists of transistors Q5 and Q6.

The output from the oscillator is taken from the collector of Q2 and is coupled through R14 to the base of Q3. Q3 is operated as a common emitter stage and its collector is directly coupled to the base of Q4 which is operated as a common collector stage. Negative feedback from the emitter of transistor Q4 is fed back to the base of Q3 through R16.

The output from the first preamplifier stage is coupled from the emitter of Q4 through C16 and R20 to the base of Q5. The collector of Q5 is directly coupled to the base of Q6 and negative feedback is taken from the emitter of Q6 and fed back to the base of Q5 through R23.

Under normal operating conditions, the emitter of transistor Q4 will normally be at about -5 volts d-c with a 4 volt peak-to-peak sine wave, and the emitter of Q6 will normally be at -10 volts d-c with approximately 6 volt peak-to-peak sine waves of the frequency to which the oscillator is tuned.

The output from the second preamplifier stage is taken from the emitter of Q6 and is coupled through capacitor C20 to the amplitude control, resistor R25.

3.4 OUTPUT AMPLIFIER

The output amplifier is again a negative feedback amplifier consisting of Q7, Q8 and Q9. The output from the preamplifier is taken from the swinger of R25 and is coupled through C22 and R26 to the base of the emitter follower Q7. The emitter of Q7 is tied directly to the base of the second emitter follower Q8 which drives the base of the output transistor Q9.

Negative d-c feedback is taken from the collector of Q9 through R34 to the base of Q7. The d-c operating point of the power output amplifier is set by adjusting the amplifier adjust control R27 for a d-c reading of +5 volts at the collector of Q9. The output from the power amplifier to the attenuator is taken from the collector of Q9 and is coupled through C27 in parallel with C28.

The a-c negative feedback for the power output amplifier is taken from the attenuator side of C27 and C28 through the parallel capacitors C29 and C30 and through R35 to the base of Q7. L4 in the emitter of Q9 and the feedback capacitor C31 serve to degenerate the amplifier more at the higher frequencies. C31 adjusts the output amplifier for flat response to 10 megacycles. The output from the preamplifier normally increases in amplitude between 1 and 10 megacycles and capacitor C31 is used to adjust for the flattest response between 1 and 10 megacycles.

3.5 METER CIRCUIT

The output from the amplifier is coupled through R38 to the peak rectifier CR3. A small amount of forward current is run through CR3 through R36 and R37. C34 and C35 filter out the ripple on the rectified voltage and the meter ME1 then monitors the average voltage across C34 and C35. R42 provides a positive voltage to offset the negative voltage which appears at the cathode of diode CR3 due to the negative current through R36 and R37.

3.6 ATTENUATOR

The attenuator provides six positions of 600 ohms and six positions of 50 ohms output impedance. In all positions of the attenuator, both 600 and 50 ohm (except for the 3 volt, 50 ohm output), the attenuator presents a 50 ohm load to the output amplifier. In the 50 ohm, 3 volt position the output is coupled directly to the output connectors on the front panel and the generator must be terminated into 50 ohms to operate properly.

R89 is shunted across the meter ME1 in the 50 ohm positions of the attenuator to change the sensitivity of the meter.

3.7 POWER SUPPLY

A +150 volt supply is derived from V101; is used as a supply for V1 in the oscillator; and is also used as a reference for the +20 volt supply. The +150 volts is divided down through R114 and R118 to the base of Q106 in the +20 volt supply. Q106 and Q107 comprise a differential amplifier with the collector of Q106 collected to the base of the series regulator Q105 through R121. Feedback to the differential amplifier is taken from the collector of Q105 through R125 and R126 to the base of Q107. The +20 volt output is set by R125 to within 1% of the nominal value.

The -20 volt supply is a standard series regulator with Q109 as the series regulator and Q108 as the feedback amplifier. The reference for the -20 volt supply is taken from the +20 volt supply through R128. Feedback to the reference amplifier Q108 is taken from the emitter of Q109 through R124 and C113.

The -10 volt supply is also a series regulated supply and uses the +20 volt supply as a reference. The reference for the -10 volt supply is taken from the +20 volt supply through R130 to the base of Q110. The supply current for the series regulator of the -10 volt supply is derived from the regulated -20 volt supply.

The +10 volt supply is a shunt regulator using Q113 as the shunt regulator and Q112 as the feedback amplifier. The reference for the +10 volt supply is taken from the -20 volt supply through R129 to the base of Q112. Feedback in the +10 volt supply regulator is taken from the emitter of Q113 through R133 and C117 to the base of Q112. The current for the +10 volt supply is taken from the regulated +20 volt supply through R137.

The +30 volt supply is a parallel regulated 10 volt supply with its negative terminal connected to the regulated +20 volts. The reference for the +30 volt supply is taken from the +10 volt bus through R103 to the base of the reference amplifier Q101. Negative feedback is taken from the +30 volt bus through R102 and C106 to the base of the reference amplifier Q101.

A -6.3 volt regulated supply is provided for the filament of V1 in the oscillator by series regulator Q102 and reference amplifier Q103. The reference for the -6.3 volt supply is provided by three forward conducting silicon diodes in series - CR111, CR112 and CR113. The -6.3 volt supply is set by adjusting R111.

SECTION IV
MAINTENANCE & CALIBRATION

4.1 COMPONENTS

Top-quality components and precision manufacturing methods have been used in this instrument to insure a long life with a minimum of maintenance. The only critical components are the frequency-determining elements C36 and R43 through R54. These components have been chosen for complementary temperature coefficients and should be replaced only by factory parts.

It is also recommended that replacement tubes and transistors be obtained from E-H Research Laboratories, Inc. We can insure your getting a satisfactory replacement part which has been proved in Model 410 circuitry.

4.2 FAN ASSEMBLY

The cooling fan is life-time lubricated and no preventive maintenance is necessary. Overheating means poor performance and high failure rates; for a long and reliable life, it is important that air flow into the instrument is not restricted.

4.3 TEST EQUIPMENT

The following test equipment is recommended for inspection and verification of the Model 410 performance.

a. An audio VTVM capable of measuring the amplitude range 10 millivolts to 3 volts over the spectrum 10 cps to 100 kc with high-impedance input or dual 50 and 600 ohm inputs.

b. A counter or EPUT meter capable of a 10 mc count.

c. An oscilloscope with at least 10 mc vertical amplifier bandpass. The oscilloscope will give a qualitative indication of distortion; for more precise distortion measurements, notch filters in conjunction with the audio VTVM or oscilloscope are required.

For servicing and troubleshooting, a standard 20,000 ohm per volt multimeter is satisfactory; however, greater precision is required in setting up power supply levels, and a d-c voltmeter capable of 1% accuracy should be used.

4.4 PERFORMANCE CHECK

A check of the Model 410 performance may be made from the front panel. For periodic maintenance it is sufficient to check frequency and amplitude calibrations. A more complete check would require distortion and stability measurements which will not be described in detail.

a. FREQUENCY. - The decade counter or EPUT meter is the most satisfactory method of checking frequency. If a counter is available, the procedure is simply to load the output of the generator with a dummy load, preferably 50 ohms; clip the counter input across the load; and read frequency directly. Each decade of the Model 410 output should be spot-checked at three or four points of the FREQUENCY dial. Frequency should be within 2% of dial settings.

Alternative methods of determining the generator output frequency include comparison with the output of a known source, preferably on an oscilloscope, or by calculating frequency from observed oscilloscope sweep times. Both of these methods are cumbersome and of questionable accuracy.

b. AMPLITUDE. - For routine checking of the output and attenuator sections of the instrument it is sufficient to make direct comparison of the indicated output with the reading of an audio VTVM across a dummy load, at some intermediate frequency.

Attenuator or metering defects will be immediately apparent, provided that the measuring system presents the proper load to the instrument as indicated by the attenuator setting.

At frequencies above 100 kc, the deficiencies of direct comparison systems with respect to shunt capacitance and meter passband become increasingly troublesome.

The method used in our plant for attenuator checks at 10 mc is to feed a fixed-gain video amplifier/detector with d-c output through a series of fixed low-loss pads which correspond to the attenuator steps. The procedure is then to switch in a step of attenuation, remove a corresponding fixed pad from the line, and check to see that the video amplifier d-c output level remains the same.

4.5 CALIBRATION PROCEDURE

The +150 volt supply should be checked to see that it is within the tolerances for the OA2 VR tube, V101. The +20 volt supply should be set to within 1% of 20 volts. The -20, +10, -10 and +30 volt supplies should be within 5% of their nominal values. The -6.3 volt supply should be set to within 1% of 6.3 volts.

After setting the power supplies, the collector voltage of the output transistor Q9 should be adjusted. This is done by observing the d-c potential of the collector of Q9 and adjusting the amplifier adjust R27 for a reading of +5 volts d-c at the collector of the output transistor Q9.

When making adjustments on the oscillator, the oscilloscope should not be attached to any lead within the oscillator loop. When observing the sine wave output, the oscilloscope may be attached to the emitter of Q4 of the first amplifier.

The first adjustment to be made is the oscillator adjust R2. This adjustment may be made with the range switch on the 100 kc or the 10 kc range. Connect an oscilloscope to the emitter of Q4 to observe the oscillator output amplitude. Starting with R2 fully counterclockwise, advance R2 in a clockwise direction. With R2 in a fully counterclockwise position, the oscillator may or may not be oscillating.

As R2 is advanced, the oscillation will build up to a maximum. Next, there will be observed a d-c shift and then a decrease in the oscillation amplitude. R2 should be adjusted to the maximum amplitude of oscillation with no d-c shift.

Turn the tuning capacitor C36 to its maximum capacity, or to the low frequency end of the range. Set the oscilloscope sweep to 1 ms/cm. Set the RANGE switch on the 100 kc range and then quickly switch to the 10 cps range. The 10 cps oscillation then should build up without any spurious oscillations.

If high frequency oscillations are observed on the 10 cycles or if the oscillator breaks into a high frequency oscillation, increase the capacity of C6 on the base of Q1. Return the RANGE switch to the 100 kc range and quickly switch back to the 10 cps range to see that the oscillations do not occur. C6 should be adjusted to its minimum capacity without these spurious oscillations being observed as the 10 cycle oscillation builds up.

By adjusting the trimmer C37, the two sections of the tuning capacitor C36 are made equal to each other. Set the RANGE switch on the 10 to 100 kc range and set the tuning capacitor to minimum frequency. Set the output amplitude to some reference point on the meter, such as the zero db point.

Now turn the tuning capacitor to maximum frequency and adjust C37 for the same amplitude on the meter as observed at the minimum frequency at this range. Next set the RANGE switch on the 1 to 10 kc range and, using a counter, set the output frequency to 1.00 kc. Loosen the two setscrews on the coupler on the side away from the tuning capacitor and, without moving the tuning capacitor, set the dial to 1.0 and retighten the setscrews. Check to see that the counter is still reading 1.00 kc. Now set the dial to the high end of the tuning range to 10.00 and adjust C37 for 100.00 kc.

With the tuning capacitor still on 10.00, change the RANGE switch to the 100 kc to 1 mc range and adjust the trimmer capacitor C39 for 1.00 mc. Then set the RANGE switch to the 1 mc to 10 mc range and adjust the trimmer capacitor C38 for 10.00 mc. Next set the RANGE switch to the 10 cps to 100 cps range and adjust the trimmer C40 for 100.0 cps.

Now set the tuning capacitor back to a dial reading of 1.0 and check the low end of all ranges. If the oscillator output is not within ±2%, then the above procedure should be repeated; i.e., set the RANGE switch on the 1 to 10 kc range, the output frequency to 1.00 kc, and reposition the dial. Then turn the dial to a reading of 10.00 and adjust C37 for an output frequency of 10.0 kc. Reset the trimmer capacitors C38, C39, and C40 at their respective frequencies.

Other points on the tuning dial may then be checked for tracking. If any point is out of the ±2% or the desired calibration accuracy, the plates on the tuning capacitor may have to be bent to bring the dial accuracy to that desired.

The response of the output amplifier is now leveled by adjusting the capacitor C31 located on the output amplifier board. Set the oscillator frequency to 1 mc on the 1 mc to 10 mc range and set the output to a level indicated by the zero db mark. Increase the frequency to 10 mc and set the trimmer capacitor C31 to the zero db reference level. The response may then be checked between 1 mc and 10 mc and C31 adjusted for the minimum variation in the output from 1 mc to 10 mc.

When tuning between 1 mc and 10 mc, it may be observed that the oscillator breaks into a spurious oscillation, which makes the output appear as an amplitude modulated carrier. If this occurs, the oscillator adjust R2 should be repositioned to eliminate the spurious modulation. Dial calibration must be rechecked if R2 is repositioned.

4.6 METER CALIBRATION

Position the attenuator to the zero dbm or 1 volt output position on the 600-ohm output impedance and terminate the output in an accurate 600-ohm load. Set the frequency of the oscillator to a frequency within the range of the voltmeter attached to the output and adjust the output amplitude for a reading on the test voltmeter for 1 volt rms.

Adjust Calibrate 1, R40, for an output meter reading of 1.0 volt. Then turn the amplitude to zero and adjust the Meter Zero Control, R36, for zero meter reading. Again, adjust the output amplitude for 1.0 volt and readjust R40 for an output meter reading of 1.0 volt. Now terminate the output into 50 ohms and turn the attenuator to the 3-volt, 50-ohm position.

Attach the test voltmeter and adjust the output for a reading of 3.0 volts and adjust Calibrate 2, R89, for an output meter reading of 3.0 volts. Next adjust the amplitude control for an output of 2.0 volts and turn the output attenuator to the -50 dbm or .003 volt position on the 600-ohm side of the attenuator. The output meter should now read full scale, or 1.0 volt.

The output distortion between 20 and 20,000 cycles may be checked with a suitable distortion analyzer or suitable notch filters may be used. Notch filters can be built for the higher frequencies such as 100 kc, 1 mc, and 10 mc.

NOTE

The cover should be on the signal generator when checking distortion, particularly at the lower frequencies.

With the cover on, a check should be made to see that there is no interaction at the lower frequencies with 60 cycles. Observe the output on the oscilloscope and synchronize the oscilloscope to the line frequency and check for any tendency for the oscillator to lock with 60 cycles or at 120 cycles. Also check for amplitude modulation with the generator tuned between 55 and 65 cps.

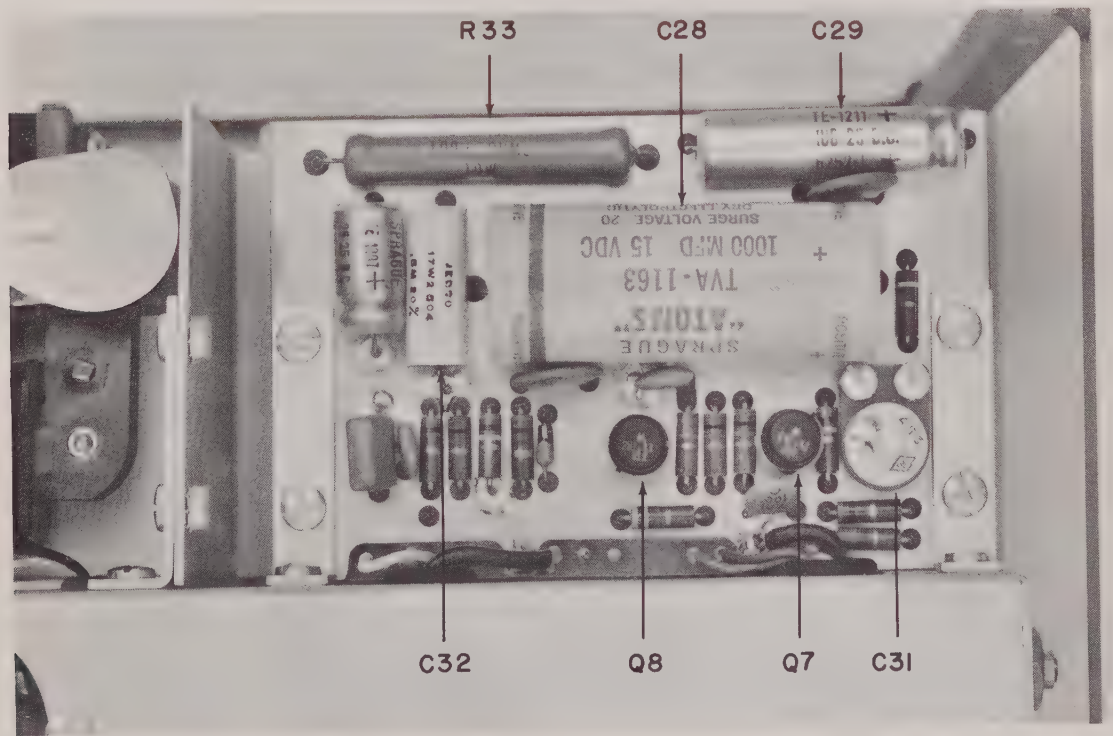

Figure 4-1. D-10830 Amplifier

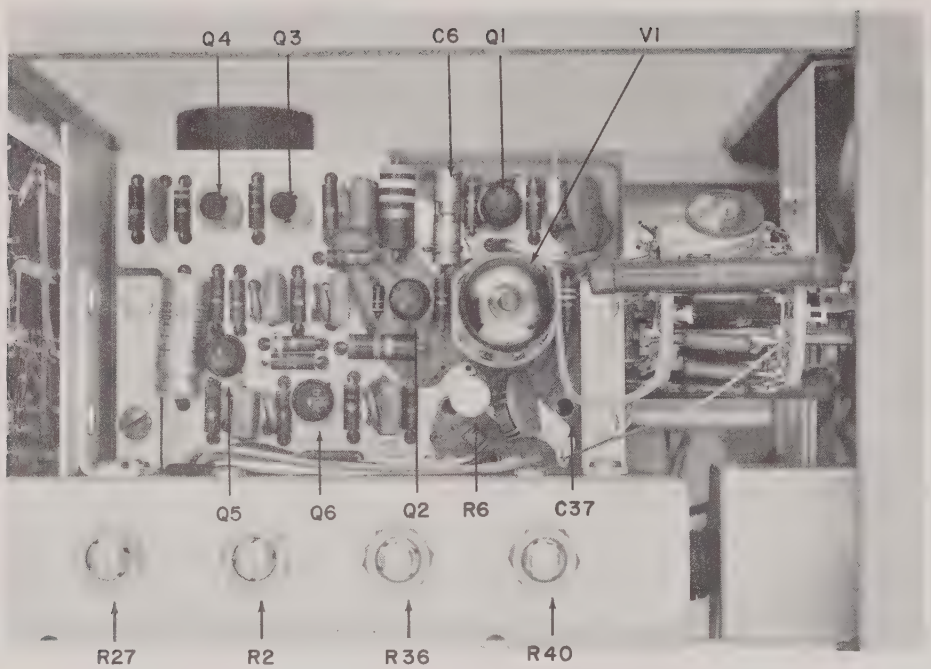

Figure 4-2. D-10830 Oscillator/Preamplifier

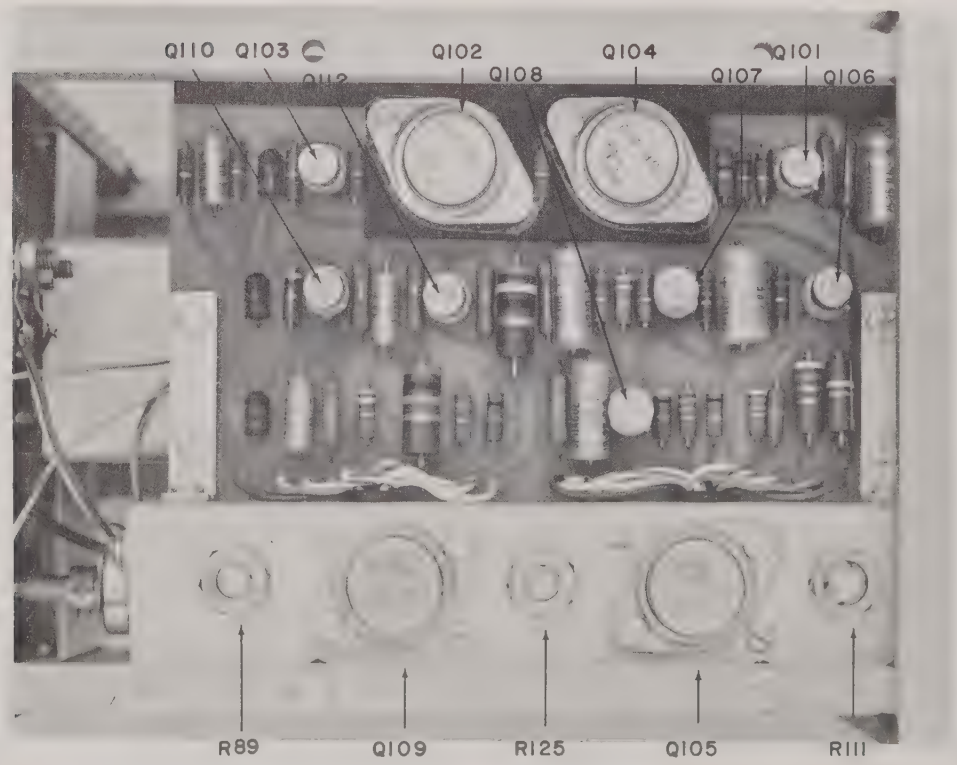

Figure 4-3. D-10831 Power Supplies

REVISIONS						
MARK	REVISION	DATE	ENGR	CHK'D	APP'D	L.O.
A	INITIAL RELEASE	5/31/61				
B	GENERAL REVISIONS	6/4/62	L.B.	R.B.H.		

PROPRIETARY INFORMATION
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D-10830 B

TITLE: MODEL 410 SIGNAL GENERATOR — D-10830 B — SHEET NO 1 OF 1

OSCILLATOR

+150V
C1 .01
R1 1K
R2 5K
OSC. ADJUST
C2 10μF 150V
L1 10T
C3 .01
C4 .001
C5 .01
CR1 IN3041A
C6 1.5-7pF
R3 13K
R4 1K 1/4W
V1 EF86
R8 15K
C7 .001
R6
R7 1.6K
L2
L3
R5 220
R10 100
-6.3V
+10V
-10V
R9 39K 2W
CR2 IN914B
R11 10
C8 .001
C9 2.2 25V
+10V
R13 10
Q1-Q2 2N1143

PREAMPLIFIER

+10V
C10 .001
C11 2.2 25V
R15 6.2K
R16 1.8K
R18 1K
C14 .001
C15 2.2 25V
R21 5.1K
R14 2K
Q3 2N966
C16 100μF 15V
Q4 2N966
R20 2.2K
R17 1K
R19 33
C17 .01
Q5-Q6 2N1143
R23 3.9K
R24 510
R22 1K
C12 2.2 25V
C13 .001
C18 .001
C19 2.2 25V
-10V
-20V
+20V
R12 750 1W
C20 500μF 50V
AMPLITUDE
R25 500
C22 100μF 15V
R26 1K
C21 .02

AMPLIFIER

+30V
AMP. ADJUST
R27 5K
R28 5.1K
R29 2K
Q7 2N1143
R30 100
C23 .001
R31 330
Q8 2N1143
R32 220
C24 .001
+20V
L4 22μH
C25 2.2 25V
C26 .001
Q9 PADT 50
C27 .01
C28 1000μF 15V
C29 100μF 25V
R33 100 10W W.W.
R34 10K
C30 .01
R35 2.4K
C31 2.5-7pF
+10V

METER ZERO

-20V
R36 500K
C32 25μF 25V
C33 .5 200V
+20V
R37 510K
CAL. 1
R40 10K
R41 2K
R42 1M
C34 .1
C35 50μF 25V
ME 1 200μA 0.1V
CR3 75V 1D6-050
R38 1K
R39 10K

S2 ATTENUATOR

ALL RESISTORS 1%
OUTPUT
CAL. 2
R89 2K
DBM VOLTS
0 1
R55 91K 5%
R56 604
R57 52.3
-10 0.3
R58 909
R59 316
R60 52.3
R61 422
-20 0.1
-30 .03
R62 1K
R63 402
R64 536
R65 52.3
R66 121
R76 316
R77 316
R78 422
-40 .01
R79 536
R80 536
R81 121
R82 10 5%
-50 .003
R83 562
R84 562
R85 38.3
600Ω
.01
R67 787
R68 53.6
R69 53.6
.03
R70 249
R71 61.9
R72 61.9
.1
R86 249
R87 61.9
R88 61.9
.3
1
R73 71.5
R74 95.3
R75 95.3
3
50Ω

FREQUENCY

C36 10-365pF
C37 7-35 pF
S1 RANGE
ALL RESISTORS 1/2%
C38 7-35pF
SHORTING CONTACTS
C39 1.5-7pF
×1M
R43 442
R49 442
×100K
R44 4.42K
R50 4.42K
×10K
R45 44.2K
R51 44.2K
×1K
R46 442K
R52 442K
×100
R47 4.42M
R53 4.42M
×10
R48 44.2M
R54 44.2M
C40 1.5-7pF

NOTES:
UNLESS OTHERWISE SPECIFIED,
1. ALL RESISTANCES GIVEN IN OHMS.
2. ALL RESISTORS ARE 1/2W, 5%
3. ALL CAPACITANCES GIVEN IN MICRO-FARADS

MATERIAL LIST

QTY	ITEM NO.	PART NO	DESCRIPTION	SCHEMATIC OR SPEC NO?

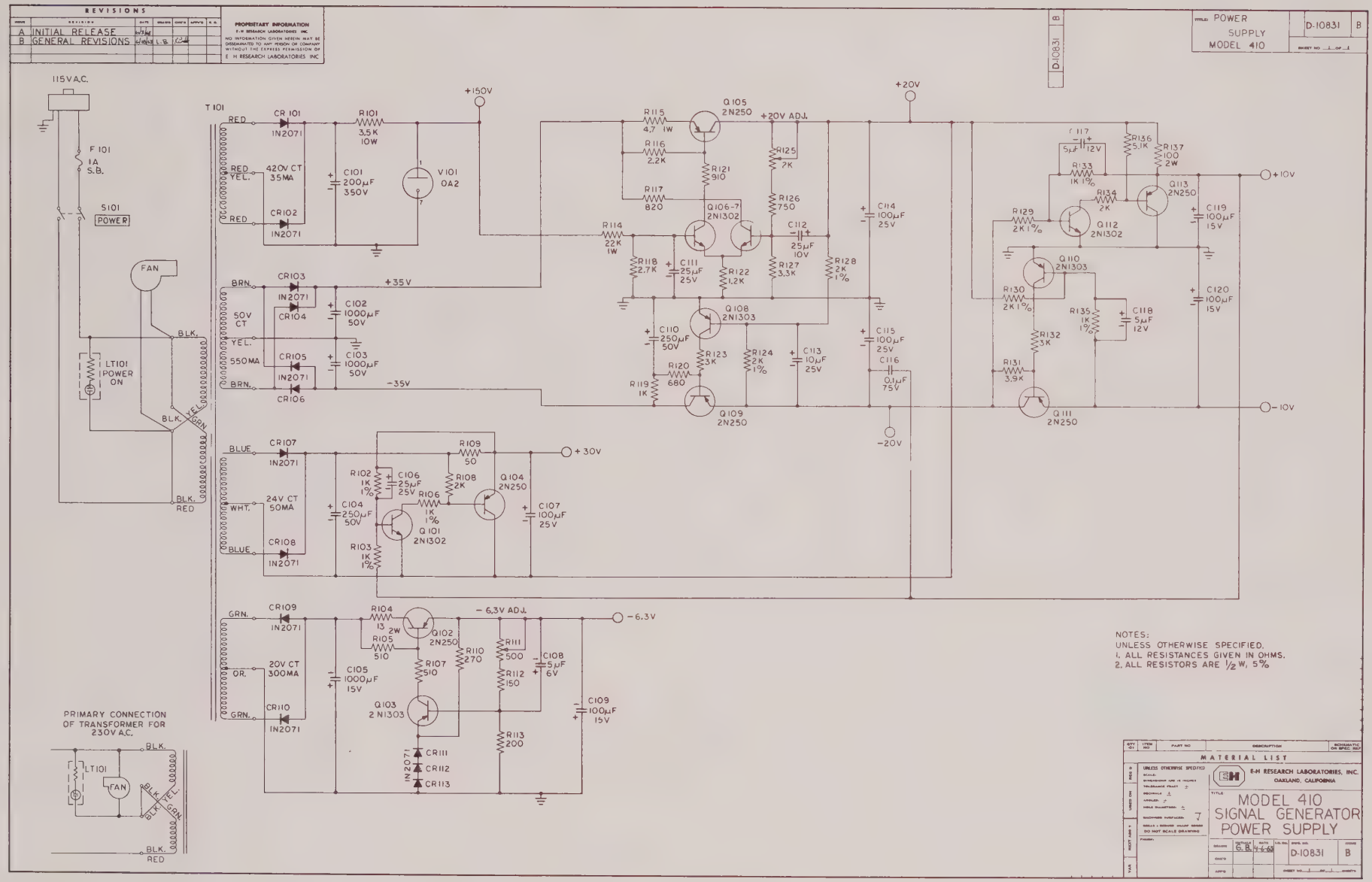
UNLESS OTHERWISE SPECIFIED
SCALE
DIMENSIONS ARE IN INCHES
TOLERANCE FRACT. ±
DECIMALS ±
ANGLES ±
HOLE DIAMETERS ±
ROUGHNESS EVERYWHERE
BREAK & REMOVE SHARP EDGES
DO NOT SCALE DRAWING
FINISH

E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE: MODEL 410 SIGNAL GENERATOR

DRAWN	G.B.	4-21-63	
TRACED			
APP'D			

D-10830 B


REVISIONS
A INITIAL RELEASE
B GENERAL REVISIONS
PROPRIETARY INFORMATION
E-H RESEARCH LABORATORIES INC
NO INFORMATION GIVEN HEREIN MAY BE DISSEMINATED TO ANY PERSON OR COMPANY WITHOUT THE EXPRESS PERMISSION OF E-H RESEARCH LABORATORIES INC
D-10831 B
TITLE: POWER SUPPLY MODEL 410
D-10831 B
115V A.C.
F 101 1A S.B.
S101 POWER
FAN
LT101 POWER ON
BLK.
YEL.
GRN
BLK.
RED
PRIMARY CONNECTION OF TRANSFORMER FOR 230V A.C.
T101
RED
CR 101 IN2071
R101 3.5K 10W
+150V
RED
YEL.
420V CT 35MA
C101 200µF 350V
V101 0A2
RED
CR102 IN2071
BRN.
CR103 IN2071
+35V
50V CT
YEL.
550MA
CR104
C102 1000µF 50V
CR105 IN2071
C103 1000µF 50V
BRN.
CR106
-35V
BLUE
CR107 IN2071
R109 50
+30V
R102 1K 1%
C106 25µF 25V
R108 2K
Q104 2N250
R106 1K 1%
C104 250µF 50V
Q101 2N1302
C107 100µF 25V
24V CT 50MA
WHT.
CR108 IN2071
R103 1K 1%
BLUE
GRN.
CR109 IN2071
R104 13 2W
-6.3V ADJ.
-6.3V
Q102 2N250
R105 510
R107 510
R110 270
R111 500
R112 150
C108 5µF 6V
20V CT 300MA
OR.
C105 1000µF 15V
Q103 2 N1303
C109 100µF 15V
CR110 IN2071
GRN.
CR111
CR112
CR113
IN2071
R113 200
Q105 2N250
+20V ADJ.
+20V
R115 4.7 1W
R116 2.2K
R117 820
R121 910
R125 2K
R126 750
Q106-7 2N1302
R114 22K 1W
R118 2.7K
C111 25µF 25V
R122 1.2K
R127 3.3K
R128 2K 1%
C112 25µF 10V
C114 100µF 25V
Q108 2N1303
C110 250µF 50V
R123 3K
R124 2K 1%
C113 10µF 25V
C115 100µF 25V
R120 680
R119 1K
C116 0.1µF 75V
Q109 2N250
-20V
C117 5µF 12V
R136 5.1K
R137 100 2W
R133 1K 1%
+10V
R134 2K
Q113 2N250
C119 100µF 15V
R129 2K 1%
Q112 2N1302
Q110 2N1303
C120 100µF 15V
R130 2K 1%
R135 1K 1%
C118 5µF 12V
R132 3K
R131 3.9K
-10V
Q111 2N250
NOTES:
UNLESS OTHERWISE SPECIFIED.
1. ALL RESISTANCES GIVEN IN OHMS.
2. ALL RESISTORS ARE 1/2 W, 5%
MATERIAL LIST
E-H RESEARCH LABORATORIES, INC. OAKLAND, CALIFORNIA
MODEL 410 SIGNAL GENERATOR POWER SUPPLY
D-10831 B
6.8 4-4-68

SECTION V
PARTS LIST

5.1 ORDERING INFORMATION

To insure your receiving the proper replacement part, please include the following information with your order.

1. Model Number and Serial Number of the instrument for which the replacement part is intended.
2. Circuit Reference of the part.
3. E-H Part Number.

Replacement parts may be ordered through your E-H Representative or from the factory.

5.2 WARRANTY

This instrument is guaranteed to be free from defects in material and workmanship. Our obligation is limited to repairing the instrument should it prove to be defective, upon our examination, within one (1) year after the purchase date. Fuses and batteries are specifically excluded from warranty. Electron tubes, transistors, and diodes are warranted for six (6) months.

For In-Warranty repair of this instrument contact E-H Research Laboratories, Customer Service Department, and provide:

1. Instrument Model Number and Serial Number
2. Full details of the nature of the malfunction

Shipping instructions, or repair information and parts, will be given you promptly.

CUSTOMER SERVICE DEPARTMENT, E-H RESEARCH LABORATORIES, INC.

163 ADELINE STREET, OAKLAND, CALIFORNIA - Phone: TE 4-3030, Area Code 415

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
NOTE:	All capacitors on the schematics, which are not shown on this list, are 1 KV, ±10%, .001 uf (Part No. 311-010).	
C1	capacitor, fxd, ceramic .01 uf, 600 v	311-012
C2	capacitor, fxd, electrolytic 10 uf, 150 wvdc	316-033
C3	capacitor, fxd, ceramic .01 uf, 600 v	311-012
C5	capacitor, fxd, ceramic .01 uf, 600 v	311-012
C6	capacitor, var, air dielectric 1.5 - 7 pf, 600 v rms	333-003
C9	capacitor, fxd, ceramic 2.2 uf, ±20%, 25 v	311-019
C11-12	capacitor, fxd, ceramic 2.2 uf, ±20%, 25 v	311-019
C15	capacitor, fxd, ceramic 2.2 uf, ±20%, 25 v	311-019
C16	capacitor, fxd, electrolytic 100 uf, 15 wvdc	316-030
C17	capacitor, fxd, ceramic .01 uf, 600 v	311-012
C19	capacitor, fxd, ceramic 2.2 uf, ±20%, 25 v	311-019
C20	capacitor, fxd, electrolytic 500 uf, 50 wvdc	316-005
C21	capacitor, fxd, ceramic .02 uf, ±20%, 1 KV	311-013
C22	capacitor, fxd, electrolytic 100 uf, 15 wvdc	316-030
C25	capacitor, fxd, ceramic 2.2 uf, ±20%, 25 v	311-019
C27	capacitor, fxd, ceramic .01 uf, 600 v	311-012
C28	capacitor, fxd, electrolytic 1000 uf, 15 wvdc	316-038
C29	capacitor, fxd, electrolytic 100 uf, 25 wvdc	316-030
C30	capacitor, fxd, ceramic .01 uf, 600 v	311-012
C31	capacitor, var, air dielectric 2.5 - 7 pf, 600 v rms	333-005
C32	capacitor, fxd, electrolytic 25 uf, 25 wvdc	316-028
C33	capacitor, fxd, metalized mylar .5 uf, ±20%, 200 v	320-008
C34	capacitor, fxd, ceramic .1 uf, +80-30%, 75 v	311-014
C35	capacitor, fxd, electrolytic 50 uf, 25 wvdc	316-037
C36	capacitor, var, air dielectric 10 - 365 pf, dual section	333-002
C37-38	capacitor, var, air dielectric 7-35 pf, 600 v rms	333-004
C39-40	capacitor, var, air dielectric 1.5 - 7 pf, 600 v rms	333-003
C101	capacitor, fxd, electrolytic 200 uf, 350 wvdc	316-027
C102-103	capacitor, fxd, electrolytic 1000 uf, 50 wvdc	316-013
C104	capacitor, fxd, electrolytic 250 uf, 5 wvdc	316-010
C105	capacitor, fxd, electrolytic 1000 uf, 15 wvdc	316-038
C106	capacitor, fxd, electrolytic 25 uf, 25 wvdc	316-028
C107	capacitor, fxd, electrolytic 100 uf, 25 wvdc	316-035
C108	capacitor, fxd, electrolytic 5 uf, 6 wvdc	316-011
C109	capacitor, fxd, electrolytic 100 uf, 15 wvdc	316-030
C110	capacitor, fxd, electrolytic 250 uf, 50 wvdc	316-010
C111	capacitor, fxd, electrolytic 25 uf, 25 wvdc	316-028
C112	capacitor, fxd, electrolytic 25 uf, 10 wvdc	316-041
C113	capacitor, fxd, electrolytic 10 uf, 25 wvdc	316-044
C114-115	capacitor, fxd, electrolytic 100 uf, 25 wvdc	316-035
C116	capacitor, fxd, ceramic .1 uf, +80-30%, 75 v	311-014
C117-118	capacitor, fxd, electrolytic 5 uf, 12 wvdc	316-043
C119-120	capacitor, fxd, electrolytic 100 uf, 15 wvdc	316-030
CR1	diode, zener, 1N3041A, 1 w, ±10%, 75 v	374-003
CR2	diode, 1N914B	376-022
CR3	diode, ID6-050	376-039
CR101-113	diode, 1N2071	376-034
F101	fuse, 1 amp, slo-blo	398-001
L1	inductor, fixed	A10723-01
L2-3	inductor, fixed	A10722-01
L4	inductor, fixed, .22 uf, ±20%	335-014
LT101	pilot light assembly, neon, red	510-008

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
Q1-2	transistor, 2N1143	663-006
Q3-4	transistor, 2N966	663-032
Q5-8	transistor, 2N1143	663-006
Q9	transistor, PADT 50	663-005
Q101	transistor, 2N1302	663-016
Q102	transistor, 2N250	663-026
Q103	transistor, 2N1303	663-011
Q104-05	transistor, 2N250	663-026
Q106-07	transistor, 2N1302	663-016
Q108	transistor, 2N1303	663-011
Q109	transistor, 2N250	663-026
Q110	transistor, 2N1303	663-011
Q111	transistor, 2N250	663-026
Q112	transistor, 2N1302	663-016
Q113	transistor, 2N250	663-026
NOTE:	All resistors on the schematic, which are not on this list, are 1/2 w, ±5%, fixed, carbon composition.	
R2	potentiometer, composition, linear taper, locking, 5 k, ±30%, 1/2 w	545-028
R6	thermistor assembly	A-10780-01
R9	resistor, fxd, composition 39 k, ±5%, 2 w	598-393
R12	resistor, fxd, composition 750 ohms, ±5%, 1 w	597-751
R25	potentiometer, composition, linear taper, 500 ohms, ±10%, 2 w	550-001
R27	potentiometer, composition, linear taper, locking, 5 k, ±30%, 1/2 w	545-028
R33	resistor, fxd, wirewound 100 ohms, ±5%, 10 w	610-004
R36	potentiometer, composition, linear taper, locking, 500 k, ±30%, 1/2 w	545-032
R40	potentiometer, composition, linear taper, locking, 10 k, ±30%, 1/2 w	545-025
R43	resistor, fxd, carbon film 442 ohms, ±1/2%, 1/2 w	606-009
R44	resistor, fxd, carbon film 4.42 k, ±1/2%, 1/2 w	606-020
R45	resistor, fxd, carbon film 44.2 k, ±1/2%, 1/2 w	606-022
R46	resistor, fxd, carbon film 442 k, ±1/2%, 1/2 w	606-019
R47	resistor, fxd, carbon film 4.42 m, ±1/2%, 1/2 w	606-021
R48	resistor, fxd, carbon film 44.2 m, ±1/2%, 2 w	604-001
R49	resistor, fxd, carbon film 442 ohms, ±1/2%, 1/2 w	606-009
R50	resistor, fxd, carbon film 4.42 k, ±1/2%, 1/2 w	606-020
R51	resistor, fxd, carbon film 44.2 k, ±1/2%, 1/2 w	606-022
R52	resistor, fxd, carbon film 442 k, ±1/2%, 1/2 w	606-019
R53	resistor, fxd, carbon film 4.42 m, ±1/2%, 1/2 w	606-021
R54	resistor, fxd, carbon film 44.2 m, ±1/2%, 2 w	604-001
R56	resistor, fxd, carbon film 604 ohms, ±1%, 1/2 w	601-020
R57	resistor, fxd, carbon film 52.3 ohms, ±1%, 1/2 w	601-074
R58	resistor, fxd, carbon film 909 ohms, ±1%, 1/2 w	601-011
R59	resistor, fxd, carbon film 316 ohms, ±1%, 1/2 w	601-022
R60	resistor, fxd, carbon film 52.3 ohms, ±1%, 1/2 w	601-074
R61	resistor, fxd, carbon film 422 ohms, ±1%, 1/2 w	601-024
R62	resistor, fxd, carbon film 1 k, ±1%, 1/2 w	601-012
R63	resistor, fxd, carbon film 40.2 ohms, ±1%, 1/2 w	601-073
R64	resistor, fxd, carbon film 536 ohms, ±1%, 1/2 w	601-028
R65	resistor, fxd, carbon film 52.3 ohms, ±1%, 1/2 w	601-074
R66	resistor, fxd, carbon film 121 ohms, ±1%, 1/2 w	601-031
R67	resistor, fxd, carbon film 787 ohms, ±1%, 1/2 w	601-035
R68-69	resistor, fxd, carbon film 53.6 ohms, ±1%, 1/2 w	601-038
R70	resistor, fxd, carbon film 249 ohms, ±1%, 1/2 w	601-040
R71-72	resistor, fxd, carbon film 61.9 ohms, ±1%, 1/2 w	601-042
R73	resistor, fxd, carbon film 71.5 ohms, ±1%, 1/2 w	601-043
R74-75	resistor, fxd, carbon film 95.3 ohms, ±1%, 1/2 w	601-044

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
R76-77	resistor, fxd, carbon film 316 ohms, ±1%, 1/2 w	601-022
R78	resistor, fxd, carbon film 422 ohms, ±1%, 1/2 w	601-024
R79-80	resistor, fxd, carbon film 536 ohms, ±1%, 1/2 w	601-028
R81	resistor, fxd, carbon film 121 ohms, ±1%, 1/2 w	601-031
R83-84	resistor, fxd, carbon film 562 ohms, ±1%, 1/2 w	601-045
R85	resistor, fxd, carbon film 38.3 ohms, ±1%, 1/2 w	601-053
R86	resistor, fxd, carbon film 249 ohms, ±1%, 1/2 w	601-040
R87-88	resistor, fxd, carbon film 61.9 ohms, ±1%, 1/2 w	601-042
R89	potentiometer, composition, linear taper, locking, 2 k, ±30%, 1/2 w	545-027
R101	resistor, fxd, wirewound 3.5 k, ±5%, 10 w	610-009
R102-03	resistor, fxd, carbon film 1 k, ±1%, 1/2 w	601-012
R104	resistor, fxd, composition 13 ohms, ±5%, 2 w	598-130
R106	resistor, fxd, carbon film 1 k, ±1%, 1/2 w	601-012
R111	potentiometer, composition, linear taper, locking, 500 ohms, ±30%, 1/2 w	545-015
R114	resistor, fxd, composition 22 k, ±5%, 1 w	597-223
R115	resistor, fxd, composition 4.7 ohms, ±5%, 1 w	597-047
R124	resistor, fxd, carbon film 2 k, ±1%, 1/2 w	601-016
R125	potentiometer, composition, linear taper, locking, 2 k, ±30%, 1/2 w	545-027
R128-30	resistor, fxd, carbon film 2 k, ±1%, 1/2 w	601-016
R133	resistor, fxd, carbon film 1 k, ±1%, 1/2 w	601-012
R135	resistor, fxd, carbon film 1 k, ±1%, 1/2 w	601-012
R137	resistor, fxd, composition 100 ohms, ±5%, 2 w	598-101
S1	switch, range	624-038
S2	switch, attenuator, index	624-029
	switching deck	624-001
	tie-point deck	624-020
S101	switch, toggle, DPST	630-006
T101	transformer, power	653-001
V1	electron tube, 6267/EF86, pentode	670-003
V101	electron tube, OA2, voltage regulator	670-007
	connector, power, 3-prong, chassis receptacle	700-018
	fan blade, 3", clockwise	493-006
	fan motor assembly, small	570-004
	fuse extractor post	396-001
	power cable, 3-prong	786-001

MP MASTER
MA35721